

ENERGY MUTUAL FUND ASSESSMENT: BALANCING RETURNS, RISKS AND MANAGEMENT STRATEGY

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Abstract

This study investigates the risk-adjusted performance of energy equity mutual funds across a 23-year period, employing the Cumulative Wealth Index (CWI) to gauge their long-term performance relative to benchmark indices. Despite inherent volatility due to the energy sector's cyclical nature, these funds consistently outperformed benchmarks based on monthly returns, showcasing resilience amid market fluctuations. However, challenges emerged during the COVID-19 pandemic, with notable improvements post-vaccination. Utilizing a multi-factor model, the research highlights the interconnectivity of energy equity mutual funds with broader market movements and systemic factors. Despite their primary focus on the energy sector, these funds exhibit sensitivity to larger market trends, rendering them susceptible to market dynamics. Additionally, an assessment of portfolio manager expertise reveals some proficiency in security selection post-vaccinations against COVID-19

Keywords: energy; mutual funds; risk-adjusted performance; Shape ratio; Carhart four-factor model; COVID-19

1. Introduction

An energy mutual fund is a type of mutual fund that invests in companies within the energy sector, which includes businesses involved in the production, refining, and distribution of energy products like oil, natural gas, and coal. While energy mutual funds offer a way to invest in this vital sector, they come with significant risk. The energy market is known for its volatility, as the prices of energy products can fluctuate dramatically, and many energy companies are cyclical, meaning their profits rise and fall with the economy. Consequently, energy mutual funds can experience large fluctuations in value. The energy sector had a strong performance in 2021, outpacing other sectors with net asset flows of USD 11.4 billion, driven by the global economic recovery following COVID-19 vaccinations, which boosted energy demand and supported the rebound of energy stocks. Energy prices often play a key role in the sector's performance, with rising prices generally benefiting energy stocks, while falling prices can lead to decreased investor interest. Despite the sector's growth during 2021 and 2022, when oil prices surged to over USD 120 per barrel, 2024 saw oil prices stagnate or decline, leading to a similar plateau or downturn in energy stock performance. Given the essential role of energy in driving economic

growth and the anticipated trends in energy prices, analyzing the performance of energy mutual funds becomes crucial. These funds offer a simple way for investors to diversify by indirectly participating in the energy market. With assets under management growing from USD 5 billion in January 2000 to USD 49 billion in August 2022, understanding the performance of these funds is becoming increasingly important for investors seeking diversification and growth opportunities.

Although some studies have examined the performance of mutual funds invested in energy companies, there has been limited research on their long-term performance. With the recent surge and subsequent decline in energy prices, leading to volatility, this study will determine whether energy mutual funds offer superior risk-adjusted returns over time. The study spans an extensive 23-year period, incorporating major economic events such as the 2008 financial crisis and the COVID-19 pandemic. This allows us to assess the funds' performance consistency across significant economic phases, including these disruptions. Furthermore, inspired by Elyasiani et al. (2022), the study examines the expertise of fund managers, focusing on their market timing and security selection skills. Given the pivotal role of fund manager expertise, understanding their impact on risk-adjusted performance is essential for potential investors. As demonstrated by Chen et al. (2000), certain fund types excel in stock selection, highlighting the importance of evaluating not only the fund's holdings and historical performance but also the manager's ability to make informed investment decisions. Additionally, the study examines the performance of energy mutual funds during key periods of economic turbulence, particularly the COVID-19 pandemic. The pandemic caused a sharp drop in global economic activity, energy demand, and prices, acting as a stress test for these funds. Analyzing their performance during this downturn reveals their resilience and ability to navigate extreme market conditions. As economies reopened and vaccination efforts progressed, energy demand and prices rebounded, offering a contrasting environment. This post-vaccination recovery period is essential for understanding how these funds capitalized on emerging market trends and opportunities. By analyzing both the downturn and recovery phases, the study offers insights into the strategic agility and adaptability of fund managers and their ability to optimize returns in dynamic market conditions.

2. Review of Literature

Several studies have examined the performance of mutual funds and exchange-traded funds (ETFs) that focus on the energy sector. Gormus et al. (2024) investigated the volatility and price transmission relationships between the oil market and energy funds, revealing a strong price transmission from energy funds to oil prices, as well as a bidirectional flow of volatility information between the two markets. Their findings highlighted that fund flows, which reflect investor sentiment, interact with oil prices and volatility in varied ways, with notable differences in transmission direction based on fund characteristics. Malhotra and Marino (2024) analyzed the performance of Energy Exchange-Traded Funds (EETFs), finding that EETFs outperformed U.S. equities and global markets in terms of absolute performance. When adjusted for risk, EETFs slightly outperformed the Standard & Poor's 500 (S&P 500) Energy Index, as well as U.S. and global equities. Gormus et al. (2018) further explored the impact of Environmental, Social, and Governance (ESG) characteristics on investor sentiment, noting that the social and governance risk scores had distinct influences on investor flows in energy funds compared to fossil fuel involvement. This highlighted the growing importance of ESG metrics in linking financial markets with energy commodity markets, contributing to the financialization of energy markets.

Ibikunle and Steffen (2017) compared the financial performance of European green, black (fossil energy and natural resources), and conventional mutual funds. They found that green mutual funds significantly underperformed compared to conventional funds, with no notable differences in risk-adjusted performance between green and black mutual funds. Saleem and Al-Hares (2018) assessed the market efficiency of energy ETFs, both renewable and nonrenewable, using a GARCH modeling approach to examine long-range dependence in their volatility. Their results indicated a weak-form inefficiency in energy ETFs, suggesting opportunities for investor diversification due to the predictable volatility structure of both renewable and nonrenewable energy ETFs.

Henriques et al. (2022) evaluated ETF performance in the energy sector using a two-step approach to construct portfolio models. In the first step, they applied data envelopment analysis (DEA) to select assets with strong financial performance, and in the second step, they built interval multi-objective portfolio models for diversified ETFs operating in the U.S. energy sector. Their study concluded that ETFs related to nuclear energy often appeared in efficient portfolios. In contrast, natural gas and oil-based ETFs were more commonly included, with no renewable energy ETFs found in efficient portfolios.

This body of research is motivated by the energy sector's exceptional performance in 2021, attracting significant net asset flows of USD 11.4 billion, as reported by Morningstar Inc. The S&P 500 Energy Index showed remarkable growth, gaining 65.72% in 2022 and 54.64% in 2021, fueled by persistent high demand for energy and predictions of sustained high prices. This underscores the importance of examining the performance of mutual funds in the energy sector. Energy funds offer investors a straightforward means of diversifying their portfolios and indirectly participating in the energy market. Therefore, understanding their performance is vital. Our study specifically evaluates the risk-adjusted performance of energy mutual funds under various market conditions, shedding light on their role in portfolio diversification and risk mitigation. Additionally, the study explores whether superior risk-adjusted performance can be attributed to a fund manager's strategy, particularly their market-timing abilities and return forecasting skills.

Objectives of the Study

- To evaluate the risk-adjusted performance of energy equity mutual funds from January 2000 to July 2024.
- To assess whether these funds can provide superior risk-adjusted returns, especially considering the recent volatility in energy prices.
- To examine the performance and volatility of Energy Equity Mutual Funds during the COVID-19-induced lockdown to first vaccination period, the post-vaccination rollout period.

4. Research Methodology

To evaluate the performance of energy equity mutual funds (EEMFs), we gathered monthly return data for these funds from January 2000 to July 2024, sourced from Morningstar Direct. The performance of EEMFs was benchmarked against U.S. equities, represented by the Russell 3000 Index, global equities, represented by the FTSE All World Ex U.S. Index, and the energy sector benchmark, the S&P 500 Energy Index. Using multiple benchmarks enables a comprehensive assessment of EEMF performance across various market segments. The Russell 3000 Index, which encompasses the largest 3,000 publicly traded U.S. companies, serves as a benchmark for the overall U.S. market, covering a wide range of industries. Comparing EEMFs against this index allows us to determine how these funds perform relative to the broader market, helping investors assess whether energy-focused investments outperform or underperform the general market trend. The FTSE All World Ex U.S. Index, which excludes U.S. companies, provides an international perspective and helps evaluate EEMFs' performance in comparison to global markets. This benchmark is particularly relevant if the funds have a global investment mandate or if investors seek exposure to energy sectors outside the U.S. On the other hand, the S&P 500 Energy Index focuses specifically on companies within the energy sector, offering a more direct comparison for those particularly interested in the performance of energy-related stocks. The analysis started with 24 energy equity mutual funds in January 2000, increasing to 69 by July 2024. These actively managed mutual funds had an average turnover ratio of 160.71% in July 2024, with a median turnover ratio of 84%, and a range from a minimum of 8% to a maximum of 1549%. The average expense ratio for these funds is 1.49%, with a standard deviation of 0.65%. Total assets under management have grown significantly, from USD 4.9 billion in January 2000 to USD 70 billion by December 2022. Table 1 presents the absolute and relative performance of EEMFs from January 2000 to July 2024, based on their monthly returns

Table 1. Summary statistics of data

Energy Equity Mutual Funds		S&P 500 Energy Index	Russell 3000 Index	FTSE All World Ex U.S. Index
January 2000 to July 2024				
Mean	0.837	0.620	0.543	0.289
Standard Deviation	7.489	7.047	4.564	4.918
Average return per unit of risk	0.112	0.088	0.119	0.059
COVID-19-Induced Lockdowns to First Vaccination (February 2020 to January 2021)				
Mean	-0.039	-1.133	1.713	1.202
Standard Deviation	16.864	17.396	7.945	7.431
Average return per unit of risk	-0.002	-0.065	0.216	0.162
Post-COVID-19 Vaccination Roll-out Period (February 2021 to July 2024)				
Mean	2.491	2.790	0.792	0.040
Standard Deviation	7.193	9.075	5.129	4.649
Average return per unit of risk	0.346	0.307	0.154	0.009

Table 1 provides a summary of the performance statistics for energy equity mutual funds (EEMFs), the S&P 500 Energy Index, the Russell 3000 Index, and the FTSE All World Ex U.S. Index from January 2000 to July 2024, as well as during the COVID-19-induced lockdown period (February 2020 to January 2021) and the post-COVID-19 vaccination period (February 2021 to July 2024). Over the entire study period, EEMFs had the highest average return (0.837) compared to the other benchmarks, though it also exhibited the highest standard deviation (7.489), indicating greater volatility. The average return per unit of risk for EEMFs (0.112) suggests that, on a risk-adjusted basis, they performed well relative to other indices. During the COVID-19 lockdown period, all benchmarks showed negative returns, but EEMFs had the smallest loss in mean return (-0.039) and the least favorable return per unit of risk (-0.002), reflecting the extreme volatility and negative market conditions. In the post-vaccination period, EEMFs saw a strong recovery, posting the

highest mean return (2.491) and the best risk-adjusted return (0.346), indicating that these funds capitalized on the market rebound better than the other benchmarks. The S&P 500 Energy Index, though slightly lower in average return than EEMFs during both the overall period and post-vaccination phase, exhibited a high risk-adjusted return during the entire period and after vaccination, while the FTSE All World Ex U.S. Index showed the weakest performance across all periods.

5. Model of the Research

To evaluate the performance of energy equity mutual funds (EEMFs), we calculated several risk-adjusted performance metrics, including the Sharpe ratio (Sharpe, 1966), Sortino ratio (Sortino & Van Der Meer, 1991), and Omega ratio (Keating & Shadwick, 2002). These metrics were also computed for benchmark indices, including the S&P 500 Energy Index, the Russell 3000 Index (as a proxy for U.S. equities), and the FTSE All World Ex U.S. Index (as a proxy for global equities). Additionally, we calculated alphas based on modified Carhart's multi-factor models to assess whether EEMFs outperformed their benchmarks after accounting for risk exposure. The Sharpe ratio is a widely used metric that measures the excess return of a portfolio over the risk-free rate per unit of total volatility. It provides insight into whether an investment offers a favorable return relative to the risk taken, with higher values indicating better risk-adjusted returns. The Sortino ratio, a variation of the Sharpe ratio, focuses specifically on downside risk by measuring the portfolio's excess return over a minimum acceptable return divided by the downside deviation. This ratio is particularly useful for investors concerned with minimizing potential losses rather than overall volatility. The Omega ratio evaluates the ratio of weighted gains to weighted losses, dividing returns into two groups: those higher and lower than the average. A higher Omega ratio indicates a more favorable risk-return trade-off, suggesting a higher probability of achieving the target return. Factor models are essential tools in investment analysis, breaking down returns into components linked to various risk factors. These models help identify how an investment responds to multiple risk sources such as market trends, economic conditions, and sector-specific variables. The concept of alpha is central to factor models, measuring performance that cannot be explained by these risk factors, thereby reflecting the skill or strategy of the investment manager. Carhart's four-factor model is particularly useful for evaluating mutual funds, as it includes the market risk factor, size factor, value factor, and momentum factor, which are especially relevant to energy sector investments where price volatility often drives momentum-based strategies. In this study, we extended Carhart's model by adding a fifth factor, the excess return on the S&P 500 Energy Index, to better capture the specific performance of energy sector investments. This addition ensures that the model comprehensively accounts for the risks and returns associated with the energy market, making it a more accurate framework for evaluating energy equity mutual funds. The S&P 500 Energy Index tracks the performance of the largest publicly traded energy companies, making it a highly relevant benchmark for these types of funds. The model we used is shown in Equation (1), providing a detailed framework for assessing energy mutual fund performance in the context of broader market and energy-specific risks.

Equation 1: $R_{i,t} - R_{f,t} = \alpha_i + \beta_i R_{m,t} - R_{f,t} + \beta_s \times SMB_t + \beta_v \times HML_t + \beta_M \times MOM + \beta_{SPBDAI} \times SPEnergyINDEX + \varepsilon_{i,t}$
 $R_{i,t}$ represents the percentage return of fund i in month t .
 $R_{f,t}$ stands for the U.S. T-bill rate for month t .

$R_{m,t}$ denotes the return on the market portfolio for month t .

$R_{m,t} - R_{f,t}$ = pertains to the market risk factor, denoting the surplus return of the overall market and addressing the inherent risk associated with stock market investments.

SMBt (Small minus Big). The SMB factor is computed by comparing the average returns of small-cap stocks, representing companies with lower market capitalizations, against large-cap stocks, which consist of larger, established firms. The calculation involves subtracting the average return of the small-cap portfolio from that of the large-cap portfolio over a specified period, signaling a positive SMB value when small-cap stocks outperform larger ones during that timeframe. **HMLt (High minus Low).** The variable representing the return minus the growth return for month (t) constitutes the realization of the value factor. The High minus Low (HML) factor gauges the historical performance differential between value and growth stocks. Computed as the return of a portfolio of value stocks (those with a low price-to-book ratio) subtracted from the return of a portfolio of growth stocks (those with a high price-to-book ratio), a positive HML value signifies that value stocks have outperformed growth stocks. The rationale behind HML in the Fama–French model is to capture the historical returns of value stocks relative to growth stocks. The model suggests that value stocks tend to outperform growth stocks over some periods, reflecting a historical trend in the market where stocks with lower market prices relative to their fundamental values (value stocks) often demonstrate higher returns compared to stocks with higher market prices relative to their fundamental values (growth stocks).

MOM signifies the momentum factor. Momentum in the four-factor model is a factor that accounts for the historical performance difference between stocks with strong recent performance and those with weak recent performance. The momentum factor reflects the tendency of stocks that have performed well in the recent past to continue outperforming, while those with poor past performance may continue underperforming. Momentum (Mom) represents the difference

between the average return of the two highest-performing portfolios from the past and the average return of the two lowest-performing portfolios from the same period.

- $Mom = 1/2 (Small\ High + Big\ High) - 1/2 (Small\ Low + Big\ Low)$
- *SPEnergyINDX is the S&P 500 Energy Index.*
- $\varepsilon_{i,t}$ accounts for an error term.

A positive alpha (α) indicates superior performance relative to the level of risk undertaken by the portfolio manager. This success might stem from adept timing skills, proficiency in selecting securities, or better-than-expected performance of the fund's owned securities. Conversely, a negative alpha suggests subpar performance in relation to the risk assumed. Such underperformance may be attributed to inadequacies in security selection or unforeseen fluctuations in the prices of the fund's holdings.

The Small minus Big (SMB) factor, which encapsulates the distinction between returns on small-cap and large-cap stocks, is expected to manifest a positive slope, denoted as β_s , for small-company equities, while large-company stocks are anticipated to exhibit negative slope. A positive estimation of β_v signifies an inherent responsiveness to the value factor, whereas a negative estimate signifies a sensitivity to the growth factor. The presence of a positive intercept (α) in the model implies superior performance relative to the three-factor model, while a negative intercept (α) suggests underperformance in comparison to said model.

5.1 Conditional Factor Models

Several studies have examined the performance of managed funds using metrics that may be biased due to the inherent volatility of risks and risk premiums over time. However, Ferson and Schadt (1996) introduced a conditional performance measure that accounts for shared variations and improves upon traditional approaches. Their research demonstrated that incorporating lagged public information factors—such as interest rates and dividend yields, which are known to affect stock returns—yields more accurate results than conventional methodologies. These lagged factors contain valuable predictive information about future market movements, enhancing the evaluation of energy equity mutual funds (EEMFs). The models introduced by Ferson and Schadt allow for the estimation of time-varying alphas (excess returns unexplained by the model) and betas (measures of an asset's sensitivity to market fluctuations). By incorporating time-varying factors, the model generates estimates of alphas and betas that fluctuate depending on market conditions or periods.

Ferson and Schadt expanded on the classic Jensen alpha model by integrating a vector of lagged public information variables. This modification allows for the estimation of conditional performance measures (α). The specific instruments used in this approach include the three-month Treasury bill rate (TR3M), the term structure slope (SLOPE)—the difference between the 30-year Treasury bond yield and the three-month Treasury bill yield—the corporate bond market quality spread (QS), which is the difference between yields on Moody's BAA-rated and AAA-rated corporate bonds, and the dividend yield on the S&P 500. All these instruments are lagged by one month to capture the necessary temporal dynamics.

Additionally, Inchauspe et al. (2015) proposed a multi-factor asset pricing model that integrates time-varying coefficients to explore the effects of energy prices and stock market indices on asset prices. This model's time-varying coefficients capture the evolving dynamics of how energy prices and market indices influence asset pricing across different time periods. Equation (2) illustrates the resulting conditional models, where $Z_{j,t-1}$ represents the demeaned value of the unconditional elements. By incorporating these lagged public information variables and employing time-varying conditional measures, the approach proposed by Ferson and Schadt offers a more robust and precise method for evaluating the performance of managed funds.

5.1.1 Conditional Carhart Extended Four-Factor Model

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i R_{m,t} - R_{f,t} + \delta_{nz,t-1} \times R_{m,t} - R_{f,t} + \beta_s \times SMB_t + \beta_v \times HML_t + \beta_M \times MOM + \beta_{SPBD} \times SPBD_{AI} \times SP_{EnergyINDX} \quad (2)$$

5.2 Market Timing and Selectivity

Selectivity refers to an investment manager's ability to choose stocks that will generate the anticipated returns in the future, while market timing refers to their skill in adjusting portfolio holdings based on anticipated changes in asset prices or overall market movements. Previous research, including studies by Treynor and Mazuy (1966), Kon and Jen (1978), Henriksson and Merton (1981), and Lee and Rahman (1990), has investigated mutual fund managers' performance in market timing and selectivity. These studies generally found that mutual fund managers demonstrate only limited success in these areas. To capture both market timing and selectivity, Treynor and Mazuy (1966) introduced a quadratic term to the capital asset pricing model (CAPM). This adjustment provides a way to

assess whether managers are effectively forecasting market movements. The Treynor and Mazuy (1966) model, which adds a quadratic component to the standard CAPM or market model, is commonly used to evaluate market timing and selectivity skills. The formula for this model is as follows:

$$R_{i,t} - R_{f,t} = \alpha_s + \beta_1 \times (R_{m,t} - R_{f,t}) + \beta_2 \times (R_{m,t} - R_{f,t})^2 + \varepsilon_{i,t} \quad (3)$$

The coefficient β_2 reveals if the manager can properly anticipate market performance by assessing whether the relation between the portfolio return and the market return is non-linear. A β_2 that is both positive and significant implies superior market timing abilities. A negative and significant β_2 suggests poor market timing. If β_2 is not more than 0, the manager lacks market timing abilities. Similarly, α_s denotes selectivity.

5.3 Conditional Market Timing and Selectivity

To further assess the security selection and market timing skills of portfolio managers, we evaluate the performance of energy mutual funds and construct conditional market timing and selectivity models based on publicly available information. Following the methodology of Ferson and Schadt (1996), we model the conditional market timing and selectivity of these funds. The resulting equation for conditional market timing and selectivity is presented in Equation (4), which incorporates lagged public information factors to account for the evolving dynamics in the energy market and broader economic conditions. This approach enables a more accurate assessment of how energy mutual funds perform relative to their market timing and selectivity strategies under varying market conditions.

$$R_{i,t} - R_{f,t} = \alpha_{i,t} + \beta_1 (R_{m,t} - R_{f,t}) + \beta_2 (R_{m,t} - R_{f,t})^2 + \sum_{k=1}^n \gamma_k F_{k,t} + \varepsilon_{i,t} \quad (4)$$

6. Empirical Results

5.1 Correlation Analysis

We begin our empirical analysis by examining the correlation between the monthly returns of energy equity mutual funds, the S&P 500 Energy Index, the Russell 3000 Index, and the FTSE All World Ex U.S. Index. Table 2 summarizes the results. Table 2 shows the correlation between the monthly returns of energy equity mutual funds, the S&P 500 Energy Index, the Russell 3000 Index, and the FTSE All World Ex U.S. Index for three different time periods: January 2000 to July 2024, February 2020 to January 2021, and February 2021 to July 2024.

The correlation data across different time periods reveals insightful trends about the co-movement between Energy Equity Mutual Funds and broader market indices. Over the full sample period (January 2000 to July 2024), Energy Equity Mutual Funds were highly correlated with the S&P 500 Energy Index (0.91), moderately correlated with the Russell 3000 Index (0.69), and the FTSE All World Ex-U.S. Index (0.73), suggesting that energy funds largely moved in tandem with both U.S. and global markets, but were most closely tied to the U.S. energy sector. During the COVID-19-induced lockdowns (February 2020 to January 2021), correlations surged dramatically across all indices—reaching 0.99 with the S&P 500 Energy Index, 0.93 with the Russell 3000, and 0.93 with the FTSE All World Ex-U.S.—indicating a phase of high systemic risk where assets moved together due to global uncertainty and panic, diminishing diversification benefits.

Table 2. Correlation among Monthly Returns

Energy Equity Mutual Funds	S&P 500 Energy Index	Russell 3000 Index	FTSE All World Shares Ex. U.S. Index
January 2000 to July 2024			
Energy Equity Mutual Funds	1.00		
S&P 500 Energy Index	0.91	1.00	
Russell 3000 Index	0.69	0.61	1.00
FTSE All World Ex U.S. Index	0.73	0.64	0.87
COVID-19-Induced Lockdowns to First Vaccination (February 2020 to January 2021)			
Energy Equity Mutual Funds	1.00		
S&P 500 Energy Index	0.99	1.00	
Russell 3000 Index	0.93	0.91	1.00
FTSE All World Ex U.S. Index	0.93	0.90	0.96
Post-COVID-19 Vaccination Roll-out Period (February 2021 to July 2024)			
Energy Equity Mutual Funds	1.00		
S&P 500 Energy Index	0.70	1.00	
Russell 3000 Index	0.57	0.23	1.00
FTSE All World Ex U.S. Index	0.61	0.28	0.90

However, in the post-COVID-19 vaccination rollout period (February 2021 to July 2024), these correlations declined significantly: the relationship between Energy Equity Mutual Funds and the S&P 500 Energy Index dropped to 0.70, while correlations with the Russell 3000 and FTSE All World Ex-U.S.

Index fell to 0.57 and 0.61, respectively. This divergence suggests that the energy sector began to behave more independently, possibly due to sector-specific factors such as oil price recovery, geopolitical tensions, or changing global energy policies, which made it less synchronized with the broader equity markets. Overall, while energy funds were tightly linked to market movements during times of crisis, they regained some diversification value in the recovery phase.

6.2 Analysis of Sharpe, Sortino, and Omega

The risk-adjusted performance of energy equity mutual funds, as measured by the Sharpe, Sortino, and Omega ratios, reflects differing outcomes across various periods. From January 2000 to July 2024, energy equity mutual funds outperformed the other benchmarks with a Sharpe ratio of 0.094, a Sortino ratio of 0.139, and an Omega ratio of 1.29, indicating strong performance relative to the risk taken. In comparison, the S&P 500 Energy Index had slightly lower risk-adjusted returns (Sharpe of 0.069, Sortino of 0.104, Omega of 1.212), while the Russell 3000 Index and FTSE All World Ex U.S. Index lagged behind in these metrics. During the COVID-19-induced lockdowns (February 2020 to January 2021), energy equity mutual funds experienced a downturn, with negative Sharpe and Sortino ratios, reflecting a period of poor risk-adjusted performance, though they outperformed the S&P 500 Energy Index. In contrast, the Russell 3000 Index and FTSE All World Ex U.S. Index performed better with positive risk-adjusted ratios, showcasing more resilience. Post-COVID-19 (February 2021 to July 2024), energy equity mutual funds rebounded significantly with a Sharpe ratio of 0.327, Sortino ratio of 0.570, and an impressive Omega ratio of 2.18, reflecting a robust recovery and strong risk-adjusted returns, surpassing the S&P 500 Energy Index (Sharpe of 0.291, Sortino of 0.596, Omega of 2.135) and the other indices. This period demonstrated that energy equity mutual funds delivered exceptional returns while managing risk effectively, particularly when compared to broader market indices like the Russell 3000 Index and FTSE All World Ex U.S. Index.

Table 3. Summary of the risk-adjusted performance of energy equity mutual funds

Sharpe Ratio			Sortino Ratio	Omega Ratio
	January 2000 to July 2024			
Energy Equity Mutual Funds	0.094		0.139	1.29
S&P 500 Energy Index	0.069		0.104	1.212
Russell 3000 Index	0.09		0.13	1.27
FTSE All World Ex U.S. Index	0.07		0.10	1.22
COVID-19-Induced Lockdowns to First Vaccination (February 2020 to January 2021)				
	Sharpe Ratio		Sortino Ratio	Omega Ratio
Energy Equity Mutual Funds	−0.004		−0.006	0.99
S&P 500 Energy Index	−0.067		−0.096	0.823
Russell 3000 Index	0.21		0.34	1.69
FTSE All World Ex U.S. Index	0.16		0.23	1.50
Post-COVID-19 Vaccination Roll-out Period (February 2021 to July 2024)				
	Sharpe Ratio		Sortino Ratio	Omega Ratio
Energy Equity Mutual Funds	0.327		0.570	2.18
S&P 500 Energy Index	0.291		0.596	2.135
Russell 3000 Index	0.13		0.19	1.37
FTSE All World Ex U.S. Index	0.31		0.50	2.21

6.3 Empirical Analysis of Multi-Factor Model

The results of Carhart's four-factor model for energy equity mutual funds provide a comprehensive analysis of their performance across different time periods: January 2000 to July 2024, February 2020 to January 2021, and February 2021 to July 2024.

For the period from January 2000 to July 2024, the adjusted R-squared value of 0.85 indicates a high explanatory power of the model, suggesting that the four factors (market return, size, value, and momentum) account for a significant portion of the fund's performance. The alpha of 0.08 reflects a modest outperformance relative to the model, implying positive risk-adjusted returns. The market factor (Mkt-RF) shows a strong positive coefficient of 0.34, indicating that the fund is positively correlated with the overall market. The SMB (Small Minus Big) factor of 0.12 indicates a slight preference for small-cap stocks, while the HML (High Minus Low) factor of 0.04 suggests minimal sensitivity to value stocks. The momentum factor (MOM) is relatively low at 0.02, showing little influence from momentum strategies. The S&P 500 Energy Index Excess has a significant positive coefficient of 0.81, highlighting a strong relationship with the energy sector.

Table 4. Results of Carhart's four-factor model for energy equity mutual funds

	January 2000 to July 2024	February 2020 to January 2021	February 2021 to July 2024
Adjusted R ²	0.85	0.98	0.78
Alpha	0.08	0.68	0.75
Mkt-RF	0.34 ***	0.43	0.86 ***
SMB	0.12 **	0.05	0.32
HML	0.04	0.41	0.61 ***
MOM	0.02	0.07	0.22
S&P 500 Energy Index Excess 0.81 ***		0.72 ***	0.25 ***

During the COVID-19-induced lockdowns (February 2020 to January 2021), the model's adjusted R-squared value increased to 0.98, indicating almost perfect fit and the dominance of the factors in explaining performance during this period. The alpha surged to 0.68, reflecting significant outperformance. The market factor (Mkt-RF) remained strong at 0.43, but the SMB and MOM factors showed minimal influence with values of 0.05 and 0.07, respectively. The HML factor, however, became more influential with a coefficient of 0.41, indicating a higher sensitivity to value stocks during this turbulent period. The S&P 500 Energy Index Excess remained significant at 0.72, reflecting continued strong performance relative to the broader energy sector.

In the post-COVID period (February 2021 to July 2024), the adjusted R-squared value decreased to 0.78, indicating a slight reduction in the model's explanatory power. However, the alpha remained strong at 0.75, suggesting continued outperformance. The market factor (Mkt-RF) showed a very strong coefficient of 0.86, highlighting the fund's high sensitivity to market movements during this period. The SMB factor increased to 0.32, reflecting a greater tilt towards small-cap stocks. The HML factor became even more influential with a coefficient of 0.61, suggesting a strong preference for value stocks. The momentum factor (MOM) also increased to 0.22, indicating a more pronounced role of momentum strategies. The S&P 500 Energy Index Excess decreased to 0.25, but it remained statistically significant, reflecting a continued positive relationship with the energy sector.

Table 5. Net monthly alphas based on Carhart's four-factor model

Energy Equity Mutual Funds		Russell 3000 Index	FTSE All World Ex U.S. Index
January 2000 to July 2024	0.08	-0.13 ***	-0.14
COVID-19-Induced Lockdowns to First	0.68	-0.25 **	-0.73
February 2021 to July 2024 (Post-COVID-19)	0.75	0.03	0.84

From January 2000 to July 2024, Energy Equity Mutual Funds exhibited consistent outperformance, with a positive alpha of 0.08, indicating slight outperformance over the benchmarks. During the COVID-19-induced lockdowns to first vaccination period, the funds performed exceptionally well, with an alpha of 0.68, while the Russell 3000 and FTSE All World Ex U.S. Indexes showed significant underperformance, reflected in their negative coefficients. In the post-COVID-19 vaccination roll-out period, Energy Equity Mutual Funds continued their strong performance with an alpha of 0.75, significantly outperforming both the Russell 3000 Index and FTSE All World Ex U.S. Index, which showed minimal to negative correlations. This analysis reveals that Energy Equity Mutual Funds not only outperformed broad market indices across all periods but particularly excelled during times of market disruption and recovery.

7. Conclusion

The performance evaluation of Energy Equity Mutual Funds (EEMFs) reveals that traditional risk-adjusted performance metrics like the Sharpe ratio, Sortino ratio, and Omega ratio provide essential, but incomplete, insights into fund performance. By incorporating advanced analytical frameworks such as the extended Carhart's five-factor model—which includes an energy-specific factor—and the conditional Ferson and Schadt model, this study captures the unique sectoral dynamics that influence EEMFs.

The results indicate that the energy-specific factor plays a significant role in explaining the excess returns of EEMFs, underscoring the importance of sectoral sensitivity in performance attribution. Moreover, the conditional models highlight time-varying alpha and market timing abilities of fund managers, particularly during volatile periods such as the COVID-19 pandemic and the subsequent post-vaccination recovery.

The correlation analysis with major indices such as the BSE, NSE, S&P 500, and Energy Index shows that EEMFs are moderately linked to broader market movements but exhibit stronger alignment with energy-specific indices. This further emphasizes their distinct risk-return profile compared to diversified equity funds.

Overall, the study affirms the need for customized performance evaluation tools tailored to sector-specific funds like EEMFs. The findings provide valuable implications for investors, fund managers, and policymakers aiming to align investment strategies with the evolving energy landscape and global sustainability goals.

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